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ABSTRACT

Research on the effects of bilingualism on cognitive development is reviewed, and two complementary models of bilingualism are developed to account for research results. It is suggested that research since 1960 shows a positive relationship between bilingualism and cognitive development, at least for some types of bilingualism. The advantage or disadvantage of becoming bilingual seems to depend on the way a subject becomes bilingual and the degree of language proficiency achieved. The "S-curve" model deals with the effects of the environment in the development of a bilingual's cognitive abilities. The second model, a bilingual's cognitive structure model, explains how different types of bilingualism are developed and why some types of bilingualism are expected to result in cognitive advantages. It is concluded that the advantage of being a coordinate bilingual (i.e., one exposed to two languages at a very early age who learns two distinct coding systems) is due to the bilingual's capacity to use language independent relations as well as relations between concepts unique to the two languages. There is no evidence that compound bilingualism (i.e., learning the second language through translation from the dominant language) will lead to cognitive advantages, while a major influence on the outcome seems to be the age of initial exposure to the second language. The social context in which the bilingual develops is also very important in determining the final outcome. (SW)

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Bilingualism and Cognitive Development

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Abstract

Research done after 1960 shows a positive trend upon the effects of bilingualism on Cognitive Development, at least for some types of bilingualism. The advantage or disadvantage of becoming bilingual seems to depend on the way a subject becomes bilingual and the degree of language proficiency that he attains. In this work, two complimentary models of bilingualism are developed to account for the experimental results. The first model ("S-curve" Model) deals with the effects of the environment in the development of a bilingual's cognitive abilities. The second, A Bilingual's Cognitive Structure Model, explains how different types of bilingualism are developed and why some types of bilingualism are expected to result in cognitive advantages.

Bilingualism and Cognitive Development

The possibility that bilingualism could have some type of effect upon intellectual functioning can be traced back as far as the 1920's to the works of Saer (1923) and Smith (1923). From that point on to this date a vast amount of research has been made on the subject. Prior to the 60's a large proportion of investigators concluded from their studies that bilingualism has detrimental effects upon congnitive functioning (e.g., Saer, 1923; Pitner, 1932; Jones and Stewart 1951; and Levingston, 1959). Explanations for their findings range from "mental confusion" and "language handicap" to language interference. A smaller proportion of investigators found little or no evidence of the influence of bilingualism on intelligence and only two empirical studies were encountered which suggest positive effects of bilingualism on intelligence (Davis and Huges, 1927; and Stark, 1940).

A positive trend on the effect of bilingualism on intelligence was initiated by the work of Peal and Lambert (1962). They pointed out that many of the early studies were poorly designed in that they failed to control confounding variables such as socioeconomic status and the bilingual's knowledge of his two languages. Having detected the major flaws of previous research, they designed an experiment in which relevant variables were matched for both control and experimental groups. The subjects were 10-year-old Canadian middle-class children divided into balanced bilinguals and monolinguals. Balanced bilinguals were considered children equally skilled in French and English. Several measures to assess the degree of bilingualism and a wide variety of intelligence

measurement tests were part of the experimental design. In contrast with previous findings, the bilingual children performed significantly better than monolinguals on verbal and nonverbal tests. To explain their results, Paul and Lambert argued that bilinguals ". . . have a language asset, are more facile at concept formation, and have a greater mental flexibility" (p. 22). They also suggest that the bilinguals appear to have a more diversified set of mental abilities than the monolinguals.

Following this line of thought and Piaget's theory of language development, Feldman and Shen (1971) investigated language related cognitive advantages of five-year-old bilingual children. Bilingual subjects were of Mexican origin and monolingual subjects were half of Mexican origin and half negroes. The main hypothesis of these researchers was that bilingual children should exhibit advantages because of having two languages, specially in object constancy, naming and in the use of names in sentences. The degree of difficulty of the three tasks was confirmed by the experiment by both bilingual and monolingual groups, with the bilinguals outperforming the monolinguals in every task. Bilingual children also performed significantly better in tasks requiring nonverbal responses.

Ianco-Worral (1972) examined the relationship between object-naming ability and bilingualism by applying Vygotsky's (1962) approach. The purpose of the study was to test one of the most remarkable effects of bilingualism observed by Leopold: "a noticeable looseness of the link between the phonetic word and its meaning" (p. 385). The subjects in her study were 4- and 5-year-old Afrikaans-English bilingual children and Afrikaans and English speaking matched monolinguals. Fifty-four

percent of the bilinguals consistently chose to interpret words in semantic dimensions. Only two children among the monolingual group showed similar choice behavior. A higher percentage of the bilinguals perceived a relationship between words in their symbolic meaning rather than their sounds. The conclusions of these findings suggest that bilinguals reach a stage in semantic development 2 to 3 years earlier than their monolingual peers. A high percentage of the bilingual youngsters perceived relationships between words in terms of their symbolic rather than their acoustic properties.

Cummins and Gulutsan (1974) reexamined the results of Peal and Lambert (1962) in a different setting and the effects of bilingualism on divergent thinking using grade-6 children as subjects. Once again children who were educated bilingually and who had achieved a moderate degree of balance between their two languages (French-English) performed at a significantly higher level than monolinguals on various measures of congnitive performance. One important point related to research and education of bilinguals was also made by the authors; the fact that there is an extremely large number of bilingual learning situations, and consequently many different ways of becoming bilingual. Research results obtained in any one bilingual learning situation are not necessarily generalizable to any other. The learning of two languages affects cognition in different ways depending on the age at which the languages are learned, whether they are learned separately or simultaneously.

A longitudinal study of bilingual and cognitive development was made by Barik and Swain (1976) using IQ data collected over a five year period

(Grades K-4) on pupils enrolled in a French immersion program and pupils in a regular English program. An interesting finding was that even though the overall results of the two groups did not differ significantly, there was a significant difference between "high" French achievers and "low" French achievers in IQ measures and subtest scores (analogies and following verbal directions).

An explanation of the last results, as well as other that will be presented later on, has been given in terms of Cummins' (1979) Developmental Interdependence Hypothesis and the Threshold Hypothesis. The first one of these proposes that the level of second language competence which a bilingual child attains is partially a function of the level of competence the child has developed in the first language at the time when exposure to the second language begins. The second hypothesis proposes that in order to avoid cognitive deficits and to allow the potentially beneficial aspects of becoming bilingual to influence their cognitive growth, the bilingual child must attain threshold levels of linguistic competence in the first language.

Oren (1981) investigated the effects of coordinate bilingualism, compound bilingualism and monolingualism on the cognitive ability of 4- to 6-year-old preschool children to label and relabel objects. Coordinate bilinguals are defined as those who have been exposed to two languages at a very early age and have learned two distinct coding systems. Compound bilinguals, on the other hand, are those who learn their second language through a process of translation from the dominant language. Results obtained by Oren showed that coordinate bilinguals performed

better than the compound bilinguals, and these in turn performed as well as monolinguals in the labeling and relabeling tests.

The implications of the findings that under certain circumstances bilinguals exhibit cognitive advantages over monolinguals was explored a step further by Quinn and Kessler (1980). Using eleven-year-old children as subjects, they compared the ability of additive bilinguals (see Lambert, 1975, for definition) versus monolinguals to formulate scientific hypothesis or solutions to science problems. The findings suggest that the students educated in more than one language will be better problem solvers than their monolingual peers. As Quinn and Kessler indicate, bilinguals should be the ideal candidates for pursuing scientific careers, and science educators must take this fact into account when recruiting students for their programs.

As a kind of paradoxical result, Mestre and Gerace (1981) found that the academic success of hispanic bilingual college students in technical fields was considerably lower than for monolingual students. Subjects in the study were given an advanced reading comprehension proficiency test, an algebraic skill test, a word problem solving test, and a language proficiency test designed to measure the speed of comprehension and the level of comprehension. Results of their tests showed monolinguals outperforming bilinguals in every task, and that for the bilinguals, language proficiency is strongly correlated with mathematics performance and GPA. An important fact related to these results that Mestre and Gerace found was that bilinguals came from a significantly lower level of socioeconomic status than monolinguals.

Looking at the aforementioned works cited one can extract certain ideas that seem to permeate all of them. First: There exist different types of bilingualism and forms of becoming bilingual. Second: Subjects that have a relatively high degree of bilingual development have cognitive advantages over their monolingual peers. Third: Language proficiency is strongly related to the bilingual's cognitive abilities. And fourth: Socioeconomic status has a major role in the bilingual's language and cognitive development. These four factors have to be integrated in a theory of bilingualism, if it is to explain the vast and sometimes seemingly discrepant works found in the literature. An attempt will be made in the following pages to integrate these factors.

An "S-Curve" Model for Bilingualism

As mentioned earlier, there exist a strong relationship between language proficiency and cognitive development. Obviously the language proficiency (LP) of a subject will depend upon its level of cognitive development (CD). However, a measure of the LP of a subject is not enough to ascertain its level of CD nor viceversa due to the fact that there exist other variables related to both. Of these, possibly the more directly related is the stage of linguistic development of the subject. Graphically the learning of a language as a function of age has the typical "S" form of the learning of the skill that does not involve any previously learned skill. A curve of LP versus age may be constructed, assuming that it is a function of the CD and language development (LD), if we knew the form of the function CD (age) and the

mathematical relationship between LP, CD, and LD. With respect to the last one it is feasible that it be of the form LP = F(DC x LD), due to the fact that if any of the two variables is zero then the LP should be zero also. Even though the complete form of CD (age) is not known it has to begin from zero, increase to a certain level, and then reach a plateau where further increase in age will result in a small increase in CD as compared with the early ages. It is likely then that the form of the LP (age) curve is that of an "S-curve" also.

As a point of departure, let us think of curve A in figure 1 as representing the relationship between LP and age for an ideal monolingual. An ideal monolingual is defined here as the individual who has received from its environment the necessary inputs so that its CD and LD increase at the maximum rate possible, in accordance to Piagetan Theory.

As suggested by the experimental works with bilingual children, their cognitive structure is more developed than for a monolingual child of the same age. We will expect then that their LP curve would be a little above the monolingual's at early ages. However, if we again assume that the environment provides for the maximum rate of LD and CD, the LD curve will always be above the monolingual's as shown in curve B of Figure 1. This means that at any age, at ideal conditions, a bilingual subject will have language and cognitive advantages over monolinguals.

What will occur under non-ideal conditions? The answer to this is a lower rate of increase in the LP curve. A bilingual subject to

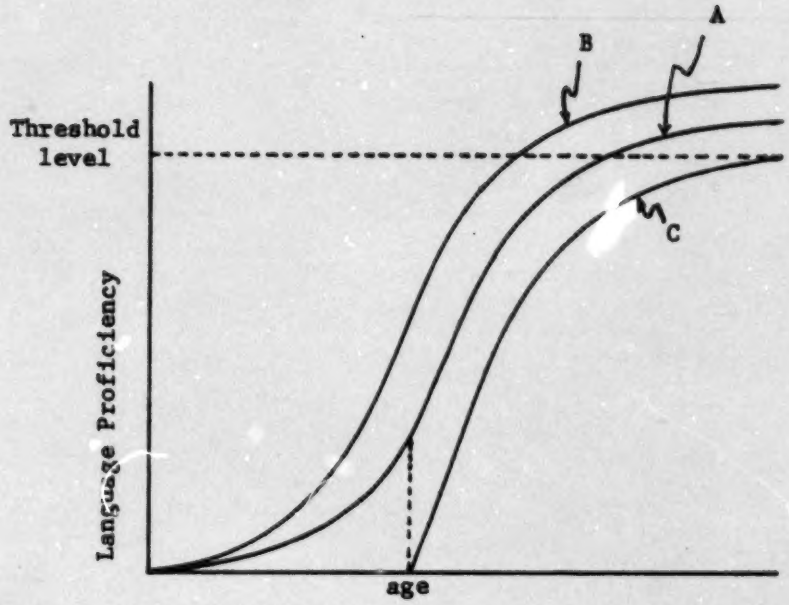

Fig. 1. Language Proficiency vs. age curve for: (A) an "ideal monolingual," (B) an "ideal coordinate bilingual," and (C) lower limit of an "ideal compound bilingual."

whom the environment does not provide for its maximum cognitive and language development will slowly begin to loose its advantage over the ideal monolingual peer and eventually fall behind him. This slower rate of increase of their cognitive and language development can prevent them from reaching the threshold level of LP needed for good college academic performance as shown in Figure 2. Notice that in the non-ideal case the LP in both languages need not be equal, so it is possible that they divide at some age in such a way that the subject will be more proficient in one language than in the other. What will be needed in order for this subject to do well at college is that he reach a LP above the threshold level in any of the two languages.

The situation for a compound bilingual is not easy to analyze in this way due to the fact that the outcomes will depend strongly on the age at which the exposure to the second language begins. An extreme case that sets the lower limit for the ideal compound bilingual can be analyzed however, the upper limit being the ideal coordinate bilingual. This extreme case will be that of a subject being removed from his L1 environment and taken to an L2 environment in such a way that it looses all interaction with the L1. Its LP curve will then start at zero at a certain age (different from zero), and begin to rise rather quickly as in the case of the learning of a skill which involves previously learned related skills. Under ideal conditions the rate of increase of the LP curve will be equal or slower than that of the ideal monolingual, so that its curve will always be under the ideal monolingual's as shown in curve C of Figure 1.

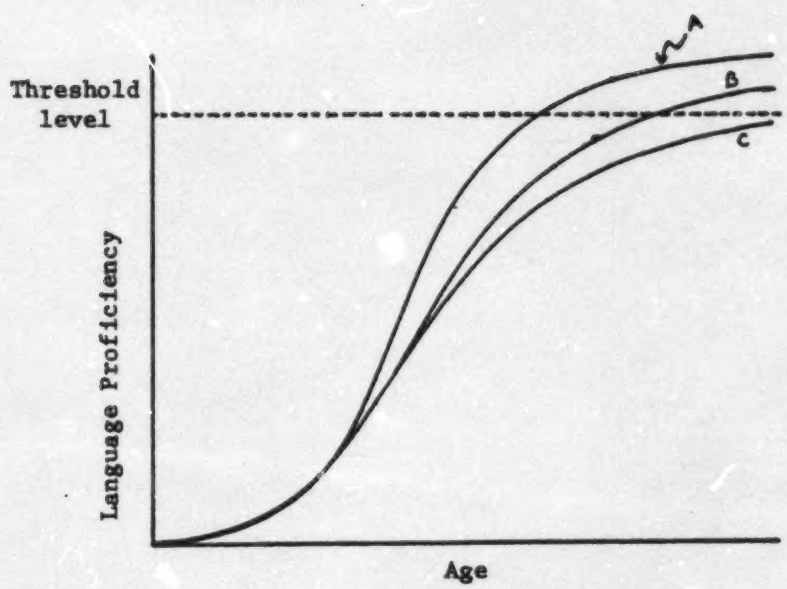

Fig. 2. Effects of environment on language proficiency vs. age curve of an "ideal" coordinate bilingual. (A): "ideal" coordinate bilingual curve. (B) and (C): shows the splitting that can occur under non-ideal conditions.

A Model for the Bilingual's Cognitive Structure

The cognitive structure of a monolingual can be represented by means of a semantic network as illustrated in Figure 3. Ovals in this figure represent concepts and the arrows represent associations between different concepts. Arrows have been labeled "semantic associations" to reflect the idea that for monolinguals, concepts are labeled by words, and relation between concepts are made in the form of propositions.

In the case of a compound bilingual child, one who has acquired a squema in the L1 at home and begins instruction ao the L2 at school, the integrations of concepts learned in L2 begin with a process of translation of the word used to represent a concept in L2 to its equivalent in L1. Figure 4 illustrates this process. In this figure concepts learned in L2 and in L1 are separated in two different parallel planes in such a way that equivalent concepts in the two languages are located one in top of the other. Concepts in the L2-plane are isolated from one another but are strongly associated with the equivalent concept in L1. In this way an association between concepts A and B in L2 is done by the indirect route A→ A'→ B'→ B. As mentioned earlier, this route will require more processing time than in the A→ B route used by a monolingual.

Notice that concepts in L1 serve as a basis where the structure of concepts in L2 will be constructed. As the compound bilingual begins his mastery of the second language, associations between concepts in L2 begin to appear. As the components of the L1 structure are bonded together, new concepts learned in L2 structure can be bonded to the

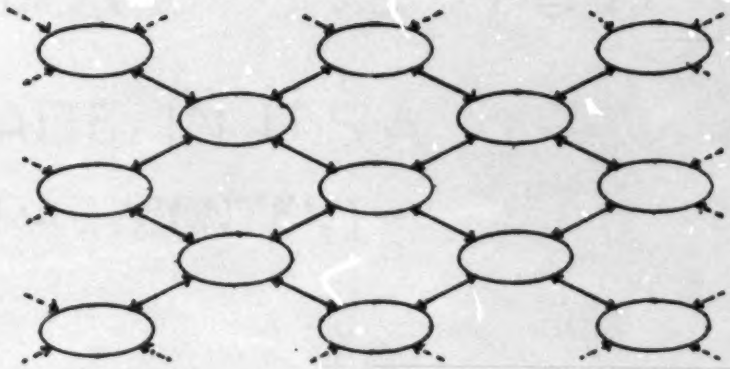

Fig. 3. Cognitive structure model of an ideal monolingual. Ovals represent concepts, and arrows connecting them, language dependent associations.

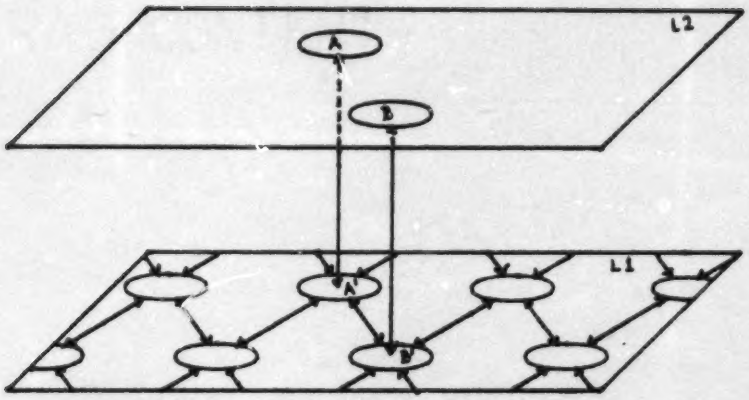

Fig. 4. Early stages in the development of a compound bilingual's L2 structure.

structure without the need of a translation association in this way the L2 structure will begin to grow idependently of the L1 structure but connected to it by the translation associations (see Figure 5).

The coordinate bilingual, on the other hand, begins creating the L1 and L2 structures independently of one another. In this sense coordinate bilinguals will require equal amounts of processing time as a monolingual for going from concept A to B. Translation associations between L1 and L2 planes appear as a consequence of the awareness that they relate the same concept. Relations between concepts A and B can be made using several routes as is the case of an association between concepts A and B'. In the last case there exist two equivalent routes. A→ A'→ B' and A→ B→ B', as shown in Figure 6. Having equated A ↔ A' and B ↔ B' the last two routes can be written as I→ II, were I and II represent concepts that can be expressed as A or A' in one case and B or B' in the other. What this means is that the coordinate bilingual acquires language independent associations between concepts, or that concepts are not tied to a particular language structure (see Fig. 7).

Figure 7 illustrates another feature of the coordinate bilingual cognitive structure. Associations between concepts that are unique to any of the languages and that provide extra routes of connection between concepts are represented as out-of-the-plane arrows. This means that the coordinate bilingual subject can take advantage of relations exclusive of any of the two languages as well as language independent relations.

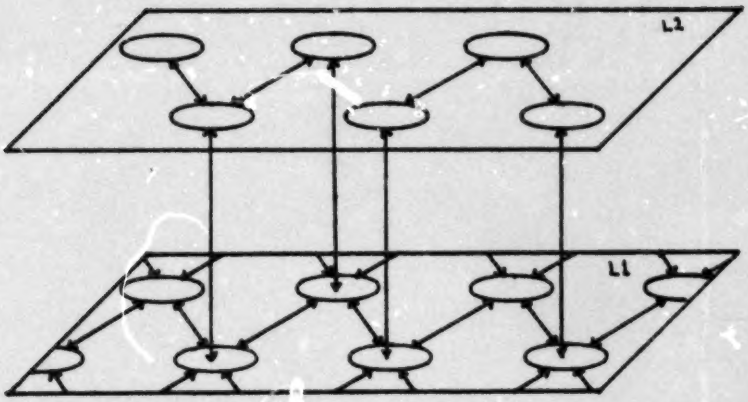

Fig. 5. Intermediate stage in the development of a compound bilingual's L2 structure.

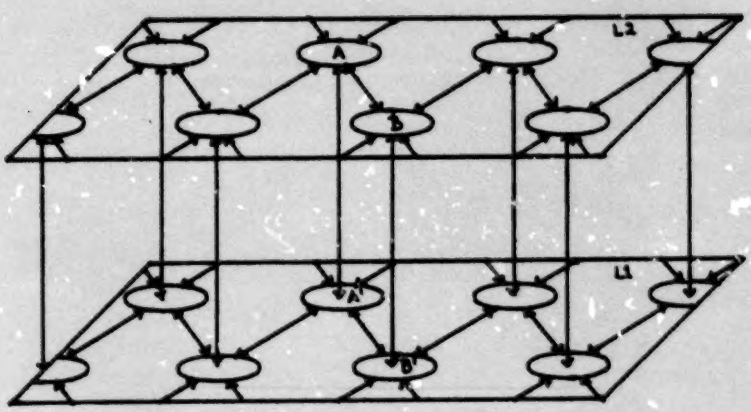

Fig. 6. Cognitive structure model of a coordinate bilingual.

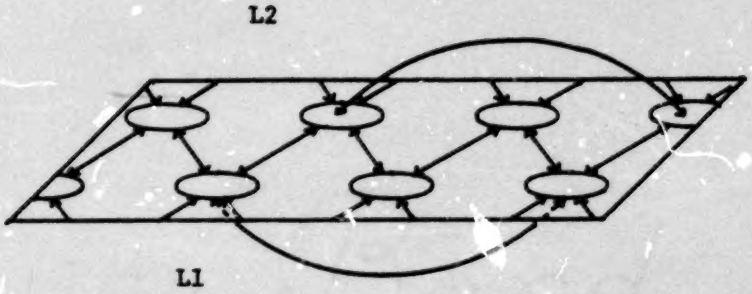

Fig. 7. Alternate model of a coordinate bilingual's structure. In-plane arrows represent language independent associations. Out-of-plane arrows represent language dependent associations.

Conclusions

The major conclusion of this work is that there is a definite advantage in becoming bilingual over being monolingual, at least for one type of bilingualism, that of coordinate bilingualism. This is due to the bilingual's capacity to use language independent relations as well as relations between concepts unique to his two languages. For the second type of bilingualism, compound bilingualism, there is no evidence, empirical or theoretical, that it will lead to cognitive advantages in every case. The major influence on the outcome seems to be the age at exposure to the second language begins. The analysis done in this work also suggests that instruction to the compound bilingual should be emphasized in the language in which the subject is more proficient, if cognitive disadvantages at later ages are to be avoided. This without forgetting that some instruction in his weaker language will help him to develop a more flexible cognitive structure.

The statements made previously can't be taken out of the social context in which the bilingual is developing, as the role of the environment is of extreme importance in determining the final outcome.

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